

DEFICIENCY IN RETENTION OF CONDITIONING
AFTER DEPRIVATION OF PARADOXICAL SLEEP IN RATS

Pierre Leconte and Vincent Bloch

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AFTER DEPRIVATION OF PARADOXICAL SLEEP IN RATS

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ABSTRACT

Forty-eight hours' elective and total deprivation of paradoxical sleep disturbed the retention of conditioning in the rat. There is less disturbance with partial deprivation (50%) of the same duration. However, after such privation, the capability of reacquiring the same learning does not seem altered. Thus paradoxical sleep would seem to play a part in the stabilization mechanisms of the memory trace. 7226*

INTRODUCTION

The hypothesis between the relationship of a memorization process and the paradoxical sleep (PS) function is based on the observation of several PS characteristics. These are (1) its absolute necessity (it always occurs during recovery after specific deprivations of greater or lesser duration); (2) its duration varies according to age (it is longer at the beginning of ontogenesis, a critical period for fundamental acquisitions); (3) unit cortical activity here is paradoxically as intense as in the waking state, which leads us to assume the existence of an active functional process.

Several authors have endeavored to check this hypothesis, but their conclusions, thus far published in part only, are contradictory. Fishbein, 1969 [1] reports that mice deprived of PS can be deficient in remembering a learned activity; Stern, 1969 [2] took stock of the deficits in the acquisition capabilities after

*Numbers in the margin indicate pagination in the foreign text.

PS deprivation in the rat, however, Albert, Cicala and Siegel 1969 [3] in the rat, and Brill and Goodman, 1969 [4] in the cat, report no impact of PS deprivation on memory functions.

Our work, which began when we had examined the above articles, proposed to test the hypothesis according to which a substantial phase of the storage mechanisms of the memory trace was accomplished during PS. For this reason we sought for an effect of elective PS deprivation on the retention of learning previously acquired but not stabilized. One would expect to find greater instability of the memory trace in animals deprived of PS after preliminary learning.

MATERIALS AND METHODS

Forty-five rats, weighing between 130 and 200 g are trained in avoidance conditioning in a cage with two compartments separated by an easily climbable barrier. This learning was chosen because it is quick and fully worked out; moreover approach conditioning would have compelled us to deprive the animals of food or drink which could have interfered with the PS deprivation. The conditioning stimulus we chose was a 1000 Hz sound transmitted for two seconds preceding an electric shock on the floor of one of the two compartments.

In the experimental treatment, which lasted 48 hours, a first group of subjects, which we will call group E, is totally deprived of PS phases. For this purpose, the so-called "swimming pool" method (Jouvet et al. [5] Cohen and Dement [6] was used: each rat was placed on a promontory 7 cm in diameter surrounded with water; the animal falls into the water and wakes up as soon as the muscular hypotonia characterizing the PS phase is manifested. The subjects in the second group (T) are placed on wider promontories (about 12 cm) which situation, according to /227

Mark, Heiner, Mandel and Godin [7] brings about a 50 percent reduction in PS phases. In a first experiment we checked the effectiveness of privation by EEG and ENG recordings. Finally the subjects in the third group (C) are put back into their cages for the 48 hours of treatment, and thus undergo all the normal phases of sleep.

PROCEDURE

1. The three groups undergo conditioning for four consecutive series of ten tests. A preliminary experiment had shown that after 40 tests the performance of the animals was between 50 and 60 percent of conditioned responses. It was necessary to choose this criterion because, aside from retention of learning, we wanted to study what happened after acquisition: for this the trace, while being sufficient not to be forgotten after 48 hours, had to be unstable enough to show any PS deprivation effects.

2. After these four series of tests, experimental treatment is applied for 48 hours: total deprivation of PS for group E, partial for group T, and no deprivation for group C.

3. After 48 hours the animals continued learning for three consecutive series of ten tests.

RESULTS

The three groups are equivalent at preliminary learning. On the fourth series, the performances were between 57.3 percent and 59.3 percent of conditioned responses (Fig. 1).

1. Retention test. During the first series of tests following treatment, the group E animals (totally deprived of paradoxical sleep) decreased in performance from 57.3% to 31% avoidances: this drop is significant within .001 and the Student t is equal to 5.47. The T group (partially deprived of PS) has a less sharp

drop: average performance, which was 58.6% before treatment, is now 42% conditioned responses after treatment; the Student t calculated between these two values is 3.13, significant to 0.01. The C group (without deprivation) stays at the same level, going from 59.3% to 60% avoidances: in this case the Student t is 0.011, and is not significant.

2. Reacquisition test. We performed a variance analysis to study the development in performance during the three series following treatment. The overall analysis of the three groups gives, for the intergroup variation, an F of 9.36 significant to .01; the variance analysis between groups C and T on the one hand, and groups T and E on the other hand, gives respective F's of 6.10 and 4.53: these two values are significant to 0.05. The difference observed at the first series following treatment is thus maintained for the second two. The F's calculated on the evolution of performance at each series are significant to .01 for the three groups; the evolution of the various curves is parallel since the interaction between the groups and the series is not significant ($F = 0.31$). /228

DISCUSSION

At the first series after treatment group C differed significantly from group T and group T differed significantly from group E. Total or partial PS deprivation has thus disturbed retention of the first 40 tests. On the other hand, the reacquisition capability does not seem affected since the three groups develop identically after treatment.

The difference found between groups C and T can be explained first by the effect of the experimental environment (discomfort) on the physical condition of the animals and then by the fact that the group T subjects only undergo 50% of the normal amount

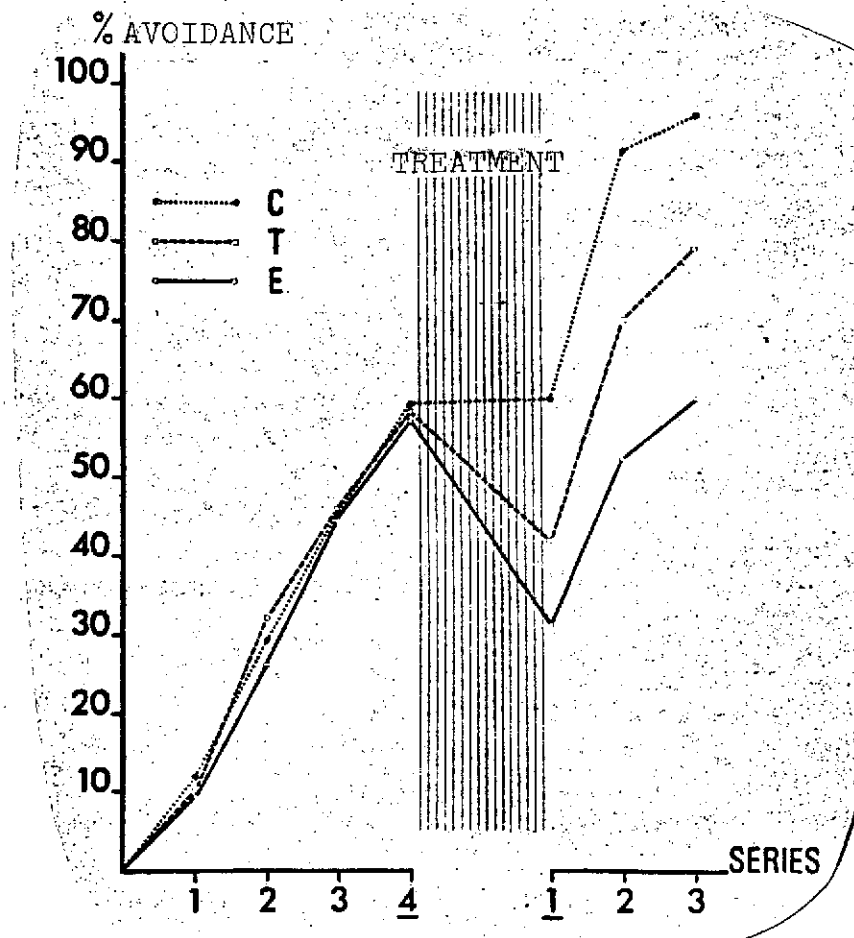


Fig. 1. Effect of PS deprivation on retention and reacquisition of conditioning.

X axis: Number of series of ten tests grouped before and after "treatment" (48 hours shown by column). During this "treatment" group C: no PS deprivation; group T: 50% PS deprivation; group E: 100% PS deprivation.

Y axis: Percentage of conditioned avoidance responses. Note the drop in performance for T and E after treatment.

of PS as suggested by the work of Mark et al [7]. If these two explanations are connected, the former brings into question the very method of the "swimming pool." Thus far, no PS deprivation method has resolved the problem of controlling the secondary /229 effects of deprivation: among these effects are the disturbance in sleeping cycles, the substantial fall in the time of slow sleep, and the physiological or even psychological consequences. We are presently endeavoring to develop a more reliable deprivation method with stricter controls.

CONCLUSION

Despite certain reservations as to the reliability of the deprivation method used, we can conclude that PS seems to play an essential part in fixing the memory trace. Although the deficit observed in the group T animals can in fact be explained by a 50% deprivation in the normal quantity of PS, we can hypothesize the existence of a quantitative relationship between the PS deprivation rate and the size of memory disturbance.

It might be thought that an artificial increase in the normal amount of SP could bring about an improvement in the retention quality of learning.

REFERENCES

* June 15, 1970 session.

1. W. Fishbein, Psychophysiology, 6, 1969, p. 225.
2. W. G. Stern, Psychophysiology 6, 1969, p. 224.
3. I. Albert, G. Cicala and J. Siegel, Psychophysiology, 6, 1969, p. 226.
4. R. W. Brill and I. J. Goodman, Psychophysiology 6, 1969, p. 226.
5. D. Jouvet, P. Vimont, F. Delorme and M. Jouvet, C. R. Soc. Biol., 158, 1964, p. 756.
6. H. Cohen and W. Dement, Science, 150, 1965, p. 1318-1319.
7. J. Mark, L. Heiner, P. Mandel and Y. Godin, Life Science, 8, 1, 1969, p. 1085.

(Psychophysiology Laboratory Research Team
associated with C.N.R.S. no. 190, Faculty
of Sciences, Post Box 36, 59-Lille distribution
North)